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(54) In the ear hearing aid.

(57) An in the ear (I.T.E.) hearing aid is formed by an ogival body (1) which is meant to be removably inserted into the acoustic meatus of the external ear, and inside the ogival body (1) there being accomodated a microphone (2) comunicating (3) with the external enviroment; an amplifier (4) being connected to the microphone (2); an electric-acoustic transducer (5), so called receiver, connected to the output of the amplifier (4) and comunicating with the duct (401, 501) having one opening at the internal end of the ogival body (1); and a housing for one or more piles or batteries for the hearing aid electric feeding. According to the invention, the electric-acoustic transducer (5) comunicates with a branched duct (501) branched off a longitudinal through duct (401) with its one end debouching at the external end of the ogival body (1) and with its other end debouching at the internal end thereof, which ducts are so provided that any cerumen and any further possibly occurring liquid secretions of the ear are not allowed to get into the branched duct (501) or reach the electric-acoustic transducer (5).

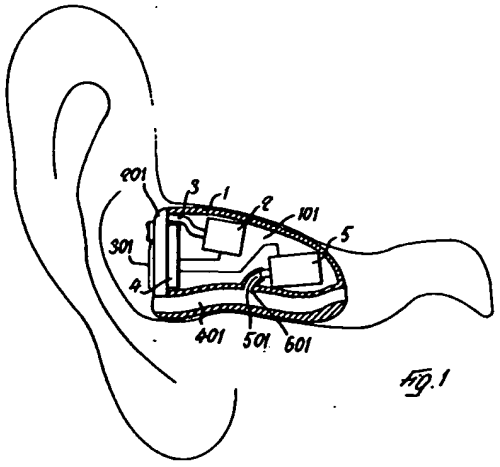

Fig. 1

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The invention concerns a I.T.E. in the ear hearing aid formed by an ogival body which is meant to be removably inserted into the acoustic meatus of the external ear, with its apex turned inwardly and with its opposite, particularly cut off ed turned outwardly, and inside the ogival body there being accomodated a microphone communicating with the external enviroment across the external side of the ogival body; an amplifier, with its input connected to the microphone; an electro-acoustic transducer, so called receiver, connected to the amplified output of the amplifier and comunicating with a duct having its outlet at the internal end of the ogival body; and a housing for one or more piles or batteries for the hearing aid electric feeding.

In the following description and in the claims, the terms internal and external are referred to the hearing aid in inserted condition ito the acoustic meatus and in connection with a user's head in its upright position.

Cerumen is presently the main cause of damages to or of a misfunctioning of a in the ear hearing aid. Indeed the duct communicating with the receiver is directed with a substantially straight course towards the internal end of the ogival body and substantially parallel to the acoustic meatus. Thus cerumen may easily get into the duct. While it is possible, on the one hand, to obviate to any occlusion which may occur in the duct by periodically disassembling the hearing aid and removing any cerumen therefrom, it is impossible, on the other hand, to protect the receiver against the chemical action of cerumen which produces irreversible damages. Particularly for the users of in the ear hearing aids, also the action due to liquid secretions having various causes, such as a simple cold, an otitis, an allergy and increased sweating promoted by an occlusion of the acoustic meatus owing to the presence of the hearing aid adds to the action of cerumen. Thus, the mean life of the receiver, which under normal conditions ranges between six months and one year, is presently reduced to a few days or a few weeks, despite the various attempts to obviate the said disadvantages, such as, for example, by the provision of small grids at the outlet of or within the duct communicating with the receiver or of a small hole provided between the receiver and the outlet of the apparatus.

The objects of the invention therefore are to improve an in the ear (I.T.E.) hearing aid of the kind as described at outset, so as to obviate to the aforementioned disadvantages, by a simple and not much expensive arrangement as well as to improve not only the mean life of the receiver but at the same time also the way of functioning af the hearing aid.

The invention achieves the said objects by an in the ear (I.T.E.) hearing aid, in which the receiver communicates with a second duct branched off the longitudinal through duct with its one end debouching at the external end of the ogival body and with its other end at the internal end thereof, which ducts are so provided that any cerumen and any further possibly occuring liquid secretions are not allowed to get into the branched duct or reach the receiver.

Advantageously the branched duct which comunicates with the receiver, is branched in the upward direction off the from the upper side of the longitudinal through duct. More particularly the longitudinal through duct is provided in the lower region of the ogival body.

According to a further feature, the branched duct communicating with the receiver is inclined relative to the axis of the longitudinal through duct in the direction of the interna end of the ogival body and the receiver is turned toward the external side of the body itself.

Thanks to these measures, any cerumen and any different liquid secretions cannot reach the receiver in any way, whereby the danger of a chemical action on the receiver is effectively avoided. In the case of an occlusion, the longitudinal through duct can be perfectely cleaned, for example, by means of a small brush or the like. The inclination of the branched duct toward the internal end of the ogival body, with reference to the axis of the longitudinal through duct, allows to avoid that the small brush, when being inserted into the longitudinal through duct from the internal end of thereof and pushed toward the opposite end of this duct, may drive the cerumen into the branched duct.

The longitudinal through duct also constitutes a duct for the acoustic waves coming directly from the external enviroment to be mixed with the acoustic waves being amplified by the hearing aid. Moreover this duct may also constructin of this body is achieved by means of suitable moulds which are shaped on the user's ear and by means of reproduction techniques usually applied also to other medical fields. The ogival body may be made of any suitable material and is inserted into a user's ear so as to have its end corrponding to the apex of the ogival body turned toward the eardrum, and its opposite cut off end turned outwardly.

The ogival body 1 is completely hollow and comprises a chamber 101 in which is accomodated a microphone 2 communicating with the outside through a duct 3. The duct 3 debouches at the external end of the body 1. The microphone 2 is connected to the input of an amplifier-circuit 4 which is advantageously fitted to the inner wall at the external end of the ogival body 1 in an adjoin-

ing relation with a housing (not shown in detail) for a feeding micro-battery. The housing for the micro-battery is provided in the end wall 201 at the external end of the ogival body 1 and in the Figures only the cover 301 for closing the housing at its outward side is visible. The acoustic waves are captured by the microphone 2 and are transformed into electric signals which are amplified and transmitted to an electro-acoustic transducer 5, so called receiver, which transforms again the amplified electric signals again into acoustic waves and which is connected to the amplified output of the amplifier 4. The electro-acoustic transducer 5 is arranged over a duct 401 which extends along the lower region of the ogival body 1 and is separated from the chamber 101 in which the microphone 2, the amplifier 4 and the transducer 5 are accomodated. The duct 401 extends in the longitudinal direction of the ogival body 1 and on one side opens at the constructin of this body is achieved by means of suitable moulds which are shaped on the user's ear and by means of reproduction techniques usually applied also to other medical fields. The ogival body may be made of any suitable material and is inserted into a user's ear so as to have its end corrponding to the apex of the ogival body turned toward the eardrum, and its opposite cut off end turned outwardly.

The ogival body 1 is completely hollow and comprises a chamber 101 in which is accomodated a microphone 2 communicating with the outside through a duct 3. The duct 3 debouches at the external end of the body 1. The microphone 2 is connected to the input of an amplifier-circuit 4 which is advantageously fitted to the inner wall at the external end of the ogival body 1 in an adjoining relation with a housing (not shown in detail) for a feeding micro-battery. The housing for the micro-battery is provided in the end wall 201 at the external end of the ogival body 1 and in the Figures only the cover 301 for closing the housing at its outward side is visible. The acoustic waves are captured by the microphone 2 and are transformed into electric signals which are amplified and transmitted to an electro-acoustic transducer 5, so called receiver, which transforms again the amplified electric signals again into acoustic waves and which is connected to the amplified output of the amplifier 4. The electro-acoustic transducer 5 is arranged over a duct 401 which extends along the lower region of the ogival body 1 and is separated from the chamber 101 in which the microphone 2, the amplifier 4 and the transducer 5 are accomodated. The duct 401 extends in the longitudinal direction of the ogival body 1 and on one side opens at the external end and on the other side at the internal end, i. e. at the apex, of the ogival body 1. In the apex area, the longitudinal through duct 401 opens substantially in a median position with respect to the ogival body 1 and to the cross-section of the acoustic meatus, i. e. radially apart from the walls thereof. The longitudinal through duct 401 has an undulated, approximately sinusoidal, shape in the vertical plane, the end section of the duct at the internal end of the ogival body 1 presenting a concave depression, and the end section of the duct at the external end of the ogival body 1 being formed by a substantially straight segment, and intermediatly between these two end section a buckle is provided, at the top of wich a branched duct 501 is branched in the upward direction off the upper side of the duct 401 and is set in communication with the electro-acoustic transducer 5. The branched duct 501 is inclined relative to the axis of the longitudinal through duct 401, in the direction of the internal end of the ogival body 1. The branched duct 501 is slightly arcuated toward the longitudinal through duct 401, and the axis of its end connected to the electric-acoustic transducer 5 forms an angle with the axis of the longitudinal through duct 401 which is more acute than the angle at its end branched off therefrom. The electro-acoustic transducer 5 is oriented in the opposite direction to the direction of transmission of the acoustic waves to the eardrum, i. e. toward the external end of the ogival body 1.

Cerumen and any other possibly occuring liquid secretions, such as sweat or secretion of different nature, accumulate in the longitudinal through duct, particularly in the region of the concave depression in the internal edn section of this duct. Since the accumulation of cerumen and liquid secretions grows from the inside toward the outside, owing to the inward inclination of the branched duct 501, the cerumen and the secretions cannot get into the branched duct and reach the transducer 5 even in the case of great amounts of cerumen and secretions, whereby any damage to the transducer due to chemical action is effectiveky avoided. In the case of the longitudinal through duct becoming occluded, this duct one can be easily and completely cleaned, by extracting the hearing aid and by using a suitable small brush, tube-brush, or the like, which is lead through the interior of the longitudinal through duct 401. The accumulated material can be pushed out of the end opposite to the end used for the insertion of a small brush or a cleaning implemet into the longitudinal through duct. In this case, the small brush or the cleaning implement is advantageously inserted from the internal endside of the ogival body 1 and directed toward the external endside of thereof, since owing to the inward inclination of the branched duct 501 communicating with the electric-acoustic transducer 5, there is no danger that part of the accumulated materialmay be driven into

the branched duct 501 with a cleaning implement.

Advantageously, the side of the branched duct 501 which is turned toward the internal end of the ogival body 1 extends by a little distance into the interior of the longitudinal through duct 401, thus forming a deflecting wing 601. Therefore, both in the case of the growth of cerumen accumulation and during cleaning, the accumulated material is further deviated away from the branched duct 501.

Referring to Figure 1, the longitudinal through duct 401 can be kept always open. In this case, a mixing is obtained of the acoustic waves coming directly fron the outside with the acoustic waves generated by the electric-acoustic transducer 5. As it appears from Figure 4, the mixing rate between the directly transmitted acoustic waves and the acoustic waves generated by the electric-acoustic transducer 5 is adjustable and settable in dependence of the optimum requirements for a patient, by providing an element 6 for reducing or partly throttling the inlet cross-section of the longitudinal through duct 401, which element can be removably fastened, for example by shrinkage, by form-locking or by screwing, thanks to complementary tappings at the terminal zone of the opening of the longitudinal through duct 401, on the external end side of the ogival body 1. When it is desired to eliminate the direct transmission of the acoustic waves to the eardrum, it is possible to provide a plug 7, for closing the opening at the external end of the longitudinal through duct 401. The plug 7 can be stably connected to the ogival body 1, for example by means of a flexible connection element 107, such as a string, a small bridge of material, or the like, whereby the danger of accidentally loosing the plug 7 is avoided.

In the outwardly closed condition ,the longitudinal through duct 401, advantageously forms a resonance chamber for the acoustic waves emitted by the electric-acoustic transducer 5. With reference to Fig. 3, the plug 7' for the longitudinal through duct 401 may also constitute a tuning element for tuning the characteristic frequency of resonance in the cavity formed by the longitudinal through duct 401 on a range of frequencies requiring a differentiated gain, particularly an increased amplification relatively to other frequency ranges. This may turn to advantage when the frequency response of the ear varies depending on the frequency. In the example of Figure 3, the plug 7' is formed by a threaded plug or pin thoroughly occluding the inner cross-section of the longitudinal through duct 401 and being screwed in an internal thread in the end section thereof at the external end side of the ogival body, whereby it is possible to adjust the depth of the pin or of the plug penetration into the longitudinal through duct 401, thus varying the characteristic frequency of resonance. The end side of the pin or of the plug is provided with means for clutching an implemet, such as for example, a diametral groove 107', by which it is possible to rotate the pin.

Obviously, a plurality of pins having a diferent lenght can be provided depending on the desired length of the longitudinal through duct 401, i. e. of the field of regulation for the characteristic frequency of resonance. One or more integrated elements (not shown) may be further provided which simultaneously perform not only the function of a plug but also the function of means for regulating the characteristic frequency of resonance and the function of means for mixing the directely transmitted acoustic waves with the acoustic waves transmitted by means of the hearing aid. For example, a threaded pin 7' may be formed with a coaxial hole 107' of a predeterminated diameter which is associable with a removable plug for closing this hole amd ooor with a plurality of means for reducing the diameter thereof.

Claims

1. An in the ear (I.T.E.) hearing aid, formed by an ogival body (1) which is meant to be removably inserted into the acoustic meatus of the external ear, with its apex turned inwardly and with the opposite, particularly cut off end, turned outwardly, and inside the ogival body (1) there being accomodated a microphone (2) comunicating (3) with the external enviroment through the external end side of the ogival body; an amplifier (4) whith its input being connected to the microphone (2); an electric-acoustic transducer (5), so called receiver, connected to the amplified output of the amplifier (4) and comunicating with the duct (401, 501) having its opening at the internal end of the ogival body (1); and a housing for one or more piles or batteries for the hearing aid electric feeding,
   characterized in that
   the electric-acoustic transducer (5) comunicates with a branched duct (501) branched off a longitudinal through duct (401) with its one end debouching at the external end of the ogival body (1) and with its other end debouching at the internal end thereof, which ducts are so provided that any cerumen and any further possibly occurring liquid secretions of the ear are not allowed to get into the branched duct (501) or reach the electric-acoustic transducer (5).

2. A hearing aid according to claim 1, characterized in that in combination with the longitudinal through duct (401) a cleaning implement such

as a small brush, a tube-brush, or the like is provided, which can be inserted into the longitudinal through duct (401) whereby the material accumulated in the longitudinal through duct (401) is pushed out of one of the ends of this duct.

3. A hearing aid according to claims 1 or 2, characterized in that means (7, 6) are associated with the longitudinal through duct (401), which are preferably removably engageable in the end section of the said duct at the external end of the ogival body (1), and are provided for closing either completely the longitudinal through duct (401) or partially so at to obtain a suitable reduction of the inside diameter of the end section thereof.

4. A hearing aid according to claim 3, characterized in that the removable means for partly closing the longitudinal through duct (401) are in form of tubular inserts (6), such as small bushings or the like, for reducing or throttling the inside diameter of the longitudinal through duct (401) according to a predetermined mixing rate between the acoustic waves directly transmitted to a user's ear from the outside and the acoustic waves transmitted by means of the electric-acoustic transducer (5).

5. A hearing aid according to claim 1 or to one or more of the preceding claims 2 to 4, characterized in that means (7') are associated with the longitudinal through duct (401) for varying the characteristic frequency of resonance and consist of elements which are engageable in the end section of the longitudinal through duct (401) on the side of the external end of the ogival body (1) and which are adjustable relatively to their depth of penetration into the longitudinal through duct (401), i. e. for adjusting the length of the cavity of resonance formed by the longitudinal through duct (401).

6. A hearing aid according to one or more of the preceding claims, characterized in that inserts are provided which are removably engageable in the external end section of the longitudinal through duct (401) and which at the same time constituite means (7') for adjusting the characteristic frequency of resonance, means (6) for adjusting the mixing rate as well as means (7) for completely closing the longitudinal through duct.

7. A hearing aid according to claim 1 and to one or more of the preceding claims 2 to 6, characterized in that the branched duct (501) communicating with the electric-acoustic transducer (5) is branched in the upward direction off the upper side of the longitudinal through duct (401).

8. A hearing aid according to claim 7, characterized in that the longitudinal through duct (401) is porvided in the lower region of the ogival body.

9. A hearing aid according to claim 7 or claim 8, characterized in that at the internal end of the ogival body (1) the longitudinal through duct (401) has its opening in a position approximately coaxial, or median relative to the said end of the ogival body (1), in any case radially spaced apart from the peripheral walls thereof.

10. A hearing aid according to claim 7 or one of the preceding claims 8 or 9, characterized in that the branched duct (501) communicating with the electric-acoustic transducer (5) is inclined relative to the axis of the longitudinal through duct (401) in the direction of the internal end of the ogival body (1), andthe electric-acoustic transducer (5) is turned toward the external end thereof.

11. A hearing aid according to claim 10, characterized in that the branchedg duct (501) is arcuated toward the longitudinal through duct (401).

12. A hearing aid according to one or more of the preceding claims 7 to 11, characterized in that the wall on the side of the branched duct (501) turned toward the internal end of the ogival body (1) terminates at a small distance into the interior of this duct (401), thus forming a deflecting wing (601) for deviating the material accumulated into this duct (401) in the opposite direction to the said branched duct (501).

13. A hearing aid according to claim 1 or to one or more of the preceding claims 2 to 12, characterized in that the longitudinal through duct (401) may have, in the vertical plane, an undulated, approximately sinusoidal shape, and is formed with a concave depression in its section between the branched duct (501) and the internal end of the ogival body (1), the branched duct (501) being branched off the intermediate buckle, and the straight-shaped end section of the duct (401) declining toward the opening at the external end of the ogival body (1).

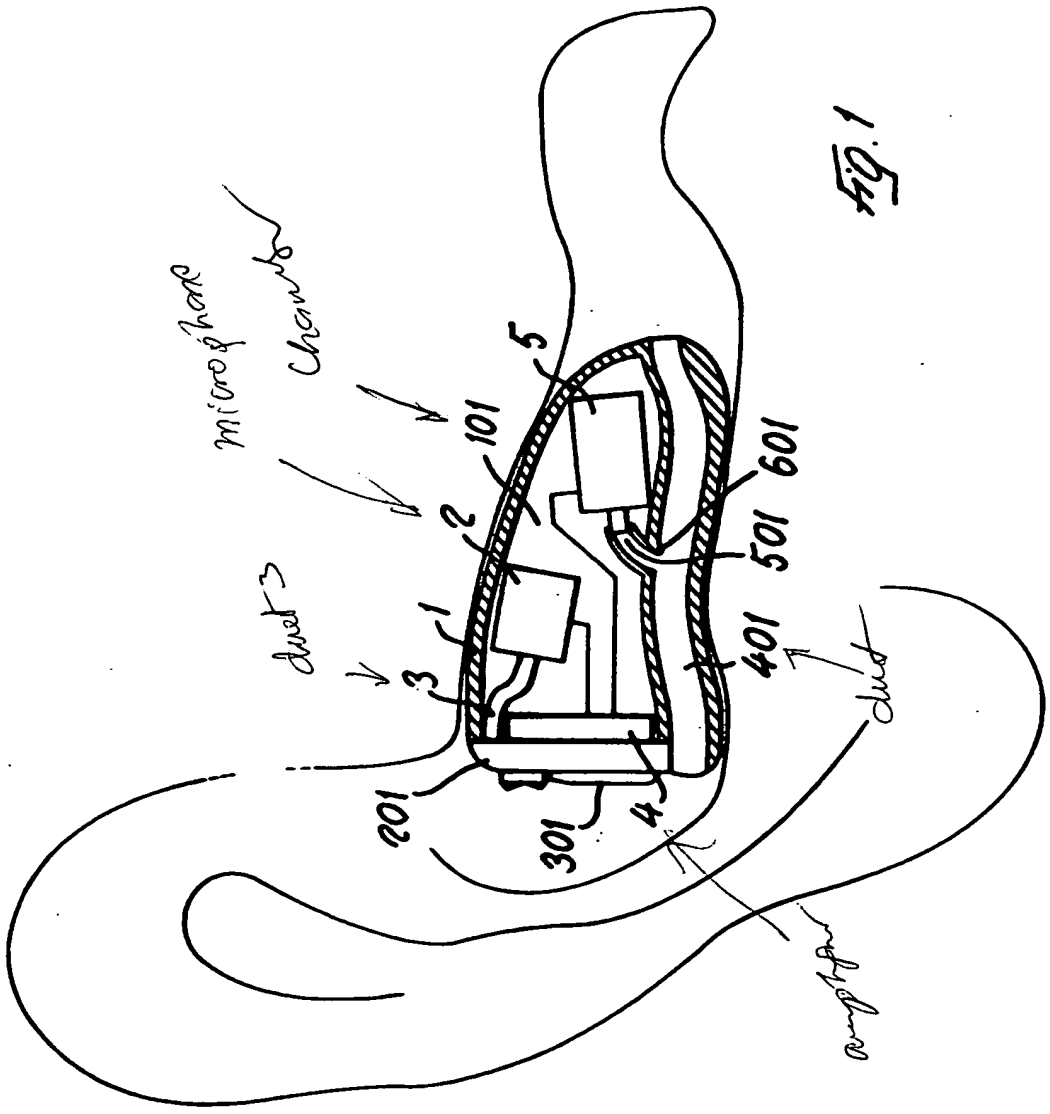
microphone
Chamber
duct
duct
amplifier
1
2
3
4
5
101
201
301
401
501
601

Fig. 1

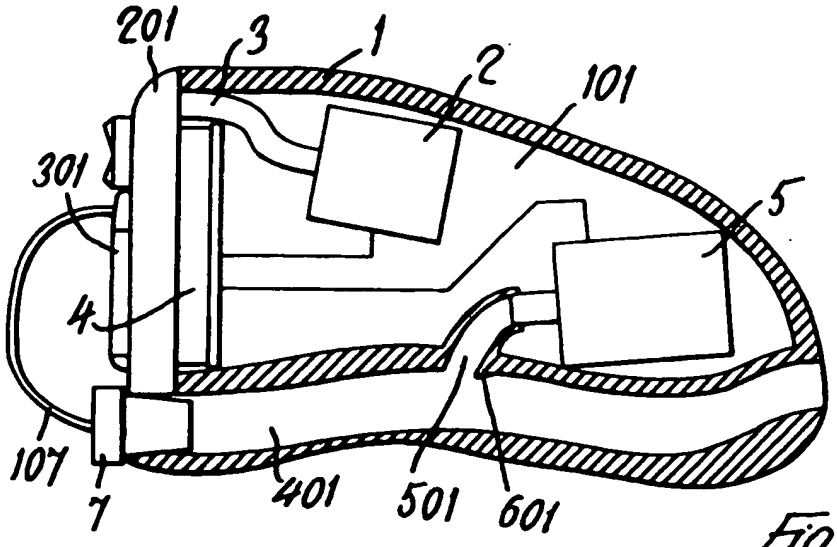

Fig.2

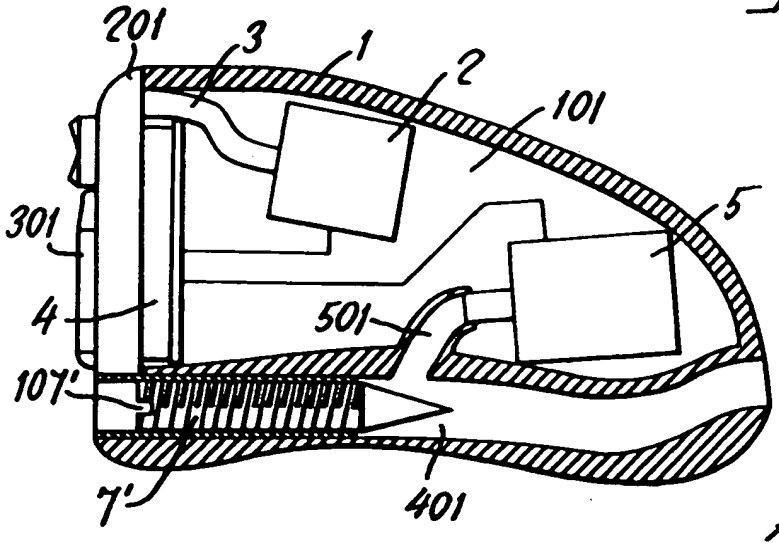

Fig.3

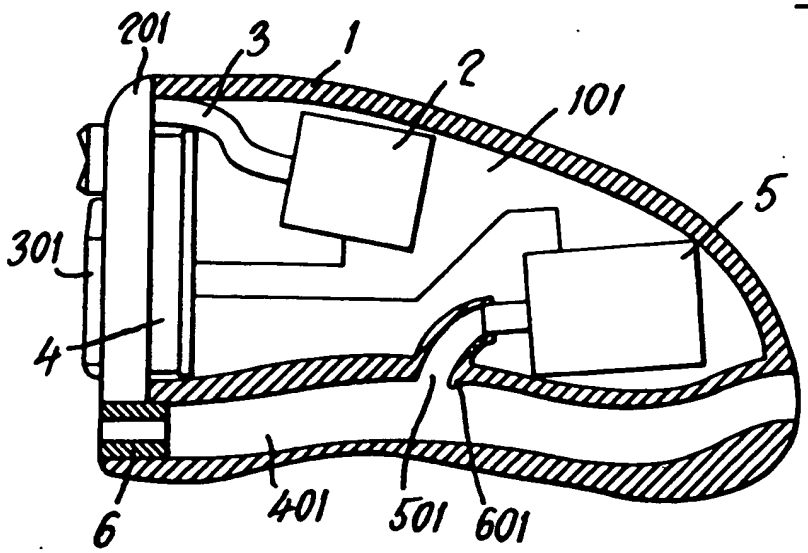

Fig.4